3. NUMERIC TARGET

This TMDL uses a numeric target to reduce phosphorus loads in order to meet water quality objectives (Table 2.1) that protect Salton Sea designated beneficial uses (Table 2.2). Achievement of the numeric target is expected to result in the Salton Sea being unimpaired by nutrients.

Numeric targets for this TMDL are based on Salton Sea Science Committee recommendations, Salton Sea BATHTUB model, scientific literature (Amrhein et al., 2003; Anderson, 2003; Anderson and Amrhein, 2002; NALMS, 2001; Reckhow et al, 1980; Tetra Tech, 2002; US EPA, 2000; US EPA, 1983), monitoring data, professional judgment, Salton Sea Nutrient Technical Advisory Committee (SS N TMDL TAC). Total Phosphorus (TP) was chosen as the water column nutrient indicator, in accordance with EPA's *Protocol for the Development of Nutrient TMDLs* (U.S. Environmental Protection Agency 1999). SS N TMDL TAC concurred with the use of TP. TP was chosen based on:

- Availability of total phosphorus data;
- Correlation between total phosphorus and chlorophyll A (algae concentration); and
- Salton Sea's relatively stable flows.

The numeric target for this TMDL is an annual average TP concentration of 35 µg/L.

The numeric target accounts for:

- Salton Sea being a warm water lake;
- Local aquatic organisms developing in conjunction with high nutrient loads; and
- Protection of all beneficial uses.

This target represents reductions in current TP concentrations, and will take several years to meet.

A. Basis for Numeric Target

Phosphorus has been found to be the limiting nutrient for growth of algae and other aquatic organisms in the Salton Sea (Anderson, 2003, Setmire, 2001). TP embodies all phosphorus forms, including dissolved orthophosphates, polyphosphates from detergents, dissolved and particulate organic phosphates from aquatic organisms, inorganic and organic particulate phosphorus from soil particles and other solids.

A.1 Trophic classification

Trophic classification provides an expression of the biological productivity of a lake. Several studies for lakes and reservoirs in the U.S. (NALMS, 2001; Reckhow et al, 1980; Tetra Tech, 2002; US EPA, 2000; US EPA, 1983) classify the following relationships among total phosphorus concentration, trophic state, and lake use:

Table 3.1 Trophic Classification of U.S. lakes

Trophic State	Total Phosphorus (µg/l)	Chlorophyll A (µg/l)	Secchi Disc Depth (meters)	Lake Use
Oligotrophic	3-18	0.3-4.5	5.4-28.3	Appropriate for cold water fisheries and water based recreation. Very high clarity and aesthetically enjoyable.
Mesotrophic	11-96	3-11	1.5-8.1	Appropriate for water based recreation. Medium clarity.
Eutrophic	16-386	3-78	0.8-7.0	Very productive for warm water fisheries. Decrease in aesthetic properties.
Hypertrophic	750-1200	100-150	0.4-0.5	Some fisheries, high levels of sedimentation and algae.

Source: NALMS, 2001; Reckhow et al, 1980; Tetra Tech, 2002; US EPA, 2000; US EPA, 1983

The boundaries between the four stages are not rigidly defined and vary within regions and beneficial uses of lake waters.

SS N TMDL TAC has expressed their desire for a eutrophic lake with healthy productive fisheries. Such a scenario minimizes the negative impact on fish-eating bird populations, which includes endangered and threatened species. This scenario also decreases events of low dissolved oxygen in the water column along with the associated fish kill episodes. With this numeric target it will be possible to restore and protect recreational Beneficial Uses.

A.2 Carlson Trophic Status Index

This is a widely used biomass-related trophic status index (TSI) for lakes (Carlson, 1977, Carlson and Simpson, 1986). TSI values range from 0 (ultraoligothrohic) to 100 (hypereutrophic). TSI is calculated independently from Secchi depth, chlorophyll A, and total phosphorus concentration.

Table 3.2 Carlson Trophic Status Index (TSI) Calculations
TSI (Chl) = 30.6 +9.81 ln (Chl)
TSI (TP) = 4.15 +14.42 ln (TP)
TSI (SD) = 60 - 14.41 ln (SD)
Source: (Carlson, 1977)

TSI is used to assess the trophic state of a lake and whether nutrients or light is limiting algal growth. If the three independent indices have similar values, phosphorus is considered to limit algal growth. This is the case of Salton Sea (discussed in the next section).

Table 3.3 Carlson Trophic Status Index (TSI) Classification	
Values	Lakes
TSI < 40	most oligothrophic
35 < TSI < 45	mesotrophic
45 < TSI < 60	eutrophic
TSI > 60	hypertrophic
Source: (Carlson, 1977)	

A.3 Numeric Target Science Committee Recommendation

The Science Committee (Amrhein et al., 2003) agreed that “eutrophic” lakes are highly productive and desirable from several aspects including water quality, wildlife habitat, recreation, and usability. The Salton Sea current classification is hypertrophic which makes the water quality of the Sea unacceptable for fish and wildlife, recreation, and protection of endangered species. Based on this, the committee concluded the ideal Salton Sea should look and act like an eutrophic lake.

The current Salton Sea chlorophyll A, Secchi disk depth and total phosphorus concentrations have a TSI index of 65 (Table 3.4). This places the Sea in the

trophic status of hypertrophic. The goal is to have the lake's TSI of 50-60, which is the range for eutrophic classification.

Table 3.4 Carlson Trophic Status Index (TSI) Calculations for the Salton Sea
TSI (Chl) = 30.6 +9.81 ln (30) = 64
TSI (TP) = 4.15 +14.42 ln (69) = 65
TSI (SD) = 60 - 14.41 ln (0.7) = 65

If the Carlson index is 50-60, then reduction of current sea conditions to the following is required:

Total phosphorus (24 - 49 ug/L - - mean value 35 ug/L)
Chlorophyll a (7 - 20 ug/L - - mean value 12 ug/L)
Secchi disk depth (2 - 1 meters - - mean value 1.4 meters)

In addition to the three standards given above, the Sea contains high concentrations of ammonium (NH_4^+). These elevated ammonium concentrations are a product of anaerobic decomposition of algal organic matter. Reductions in phosphorus concentrations in the Sea will reduce algal blooms, which fuel the formation of ammonium. Reducing the ammonium concentrations will have a direct effect on the ammonia (NH_3^o), which is highly toxic to fish. Control of ammonium is also recommended; specifically, reductions that will lower the current average summer ammonium concentrations from 2.5 mg/L to a level non-toxic to the most sensitive fauna (fish), about 0.6-1.0 mg/L (Holdren and Montano, 2002; SWRCB, 1997; USEPA, 1999).

B. Numeric Target

The numeric target proposed for this TMDL was based on Carlson Trophic Status Index and U.S. EPA Trophic Classification of U.S. lakes recommendations. The 35 µg/L target for total phosphorus is within the range for eutrophic lakes and reservoirs (Amrhein et al., 2003, USEPA, 1999).

Table 3.2. Numeric Target and Indicators for Salton Sea Nutrient TMDL.		
Indicator	Target Value	Reference
Total P concentration[a]	Annual mean no greater than 35 µg/L	Amrhein et al., 2003, USEPA, 1990, USEPA, 1999,
Chlorophyll a concentration[b]	Summer mean no greater than 12 µg/L	Amrhein et al., 2003, USEPA, 1990, USEPA, 1999
Secchi disc depth[b]	Annual mean no lower than 1.4 m	Amrhein et al., 2003, USEPA, 1990, USEPA, 1999
Ammonium[b]	Summer mean no greater than 1.0 mg/L	Amrhein et al., 2003, Holdren and Montano, 2002; SWRCB, 1997; USEPA, 1999
Dissolved oxygen[b]	Depth average no less than 5 mg/L	Basin Plan, Chapter 3, page 3-2 (Water Quality Objective)
a. source targets related to load allocation b. monitoring targets that will not be used for load allocation		

Indicators and targets for parameters other than total phosphorus are also proposed in order to track the recovery from nutrient impairment. Chlorophyll A is an important measure of algae response to nutrient loads. Secchi disc depth (transparency) and dissolved oxygen also serves as a measure of response to nutrient loads (USEPA, 1990, USEPA, 1999).

C. Existing Conditions Compared to Numeric Target

Table 3.3 compares the most recent TP measurements at the Salton Sea and the TMDL numeric target.

Table 3.3: Comparison of Existing TP to Numeric Target		
Location	**Existing TP (µg/L)**	**Target TP (µg/L)**
Salton Sea	69*	35
*Annual average concentration based on data from Holdern and Montano (2002) and Anderson and Amrhein (2002)		

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